DISTRIBUTED MODAL SIGNAL OF THIN PARABOLOIDAL SHELLS

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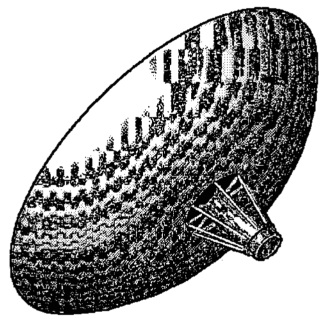
ABSTRACT

Flexible paraboloidal shell of revolution is considered one of the most difficult geometry among all shell and non-shell structures, such as spherical shells, cylindrical shells, conical shells, plates, rings, beams, etc. Often space structures and civil structures are designed based on the paraboloidal shell, because of its functionality, beauty, and strength. Static and dynamic vibration analyses of these paraboloidal shells have been investigated analytically, numerically or experimental over the years. However, due to its complexity, analytical solutions and experimental data are still scarce and only limited to simple boundary conditions. Thus, numerical (finite element) technique becomes popular and useful in engineering design and applications. This paper is to present an (analytical) assumed solution technique and to evaluate distributed sensing characteristics – modal voltages – of paraboloidal shells laminated with distributed piezoelectric layers.



Piezoelectric materials have two distinct electromechanical behaviors: the direct effect and the converse effect; the former is applied to sensor applications and the latter is applied to actuator and control applications. Due to the dual-function characteristics, piezoelectric laminated structures and systems are popular in recent development of smart structures and structronic systems. Since the paraboloidal shell of revolution belongs to the generic double-curvature shell family, a mathematical model represented in partial differential equations of the paraboloidal shells of revolution can be derived from the thermo-electromechanical equations of a generic double-curvature piezo-thermoelastic shell. Also, the distributed sensing signal can be estimated based on the simplified shell distributed sensing equation using the Lamé parameters and the radii of in-plane curvature. Applying the modal expansion concept and calculating modal strains of the natural modes, one can define the sensing voltage distribution and further plot the

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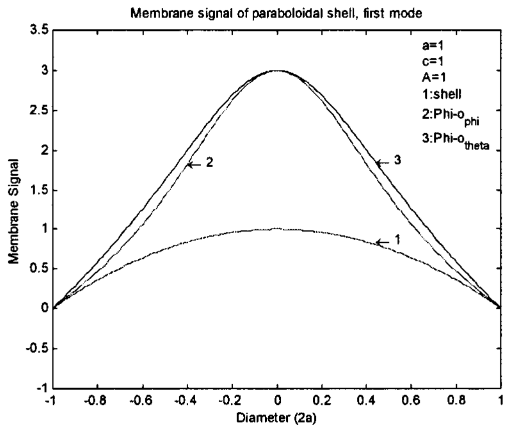
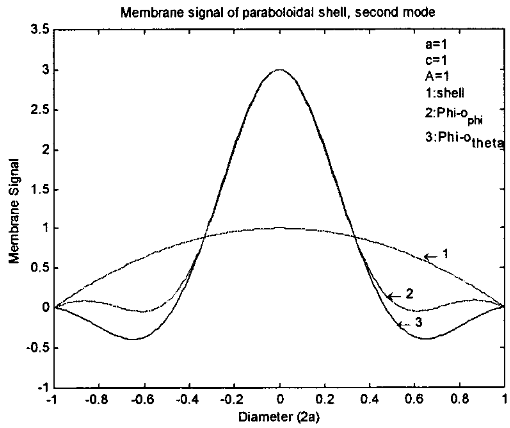
spatial distribution of modal voltages. Because the natural modes are distinct, these modal voltages are also distinct to these natural modes. Analytical solutions and modal voltages of the paraboloidal shells are presented and evaluated.





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